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Glass Options for a Healthy Built Environment

Kayla Natividad
Pilkington | NSG

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Questions will be addressed at the conclusion of the presentation.

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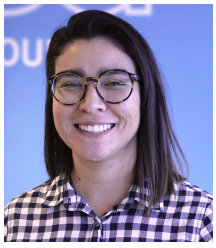
Glass Options for a Healthy Built Environment



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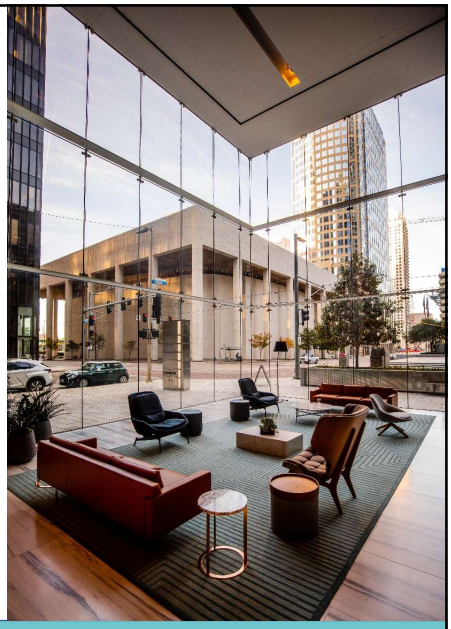
Course Overview

When evaluating material surfaces in buildings, there are a wide variety of characteristics that should be considered such as durability, haptics, aesthetics, performance, and cleanability. One key factor is the impact on occupant health and safety in terms of air quality, daylighting, and pathogen longevity on surfaces.

Glass is an inherently durable and highly sought-after building material for combination of properties like transparency, durability, easy-to-clean, and structural properties. By treating the glass surfaces of a building windows with an antiviral and anti-bacterial coating, the interior quality of the building can be greatly enhanced. The built environment can be improved by inactivating pathogens after contact with an activated coating surface which leads to reduced pathogen exposure risk. These specialized coatings can also lead to NOx and VOC reductions which improve indoor air quality.

By understanding the potential benefits provided by specialty glass applications, the window design can be adjusted to maximize occupant health considerations while still achieving the design criteria.



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Learning Objectives

Upon completion of this course, the participant should be able to:

- Describe material and human consideration in material selection
- Explain difference between antibacterial/antiviral technologies
- Understand how photocatalytic reaction can inactivate bacteria and viruses
- Explain how VOCs impact indoor air quality and describe methods to mitigate

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Outline

I.Defining The “Built Environment”

II. Material and Human Considerations in Design

III. Glass Technologies

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Defining The Built Environment

US EPA defines the Built Environment as:

"… the man-made or modified structures that provide people with living, working, and recreational spaces."

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Defining The Built Environment

The built environment significantly affects human health.

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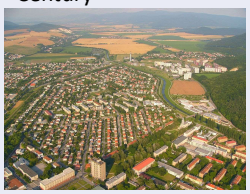
The Built Environment and Human Health

	Issues	Solutions
19th Century 	- Unsanitary, industrial cities - Overcrowding - Short life expectancy due to infectious disease	- Urban planning - Comprehensive sewer systems - Improved building design
20th Century 	- Proximity between industrial and residential neighborhoods - Human Behaviors - Building product ingredients	- Antibiotics - Zoning ordinances - Smoking restrictions - Laws and regulation on production with toxic substances (i.e. lead and asbestos)

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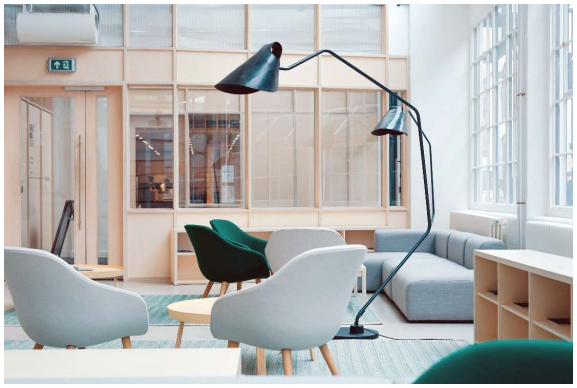
The Built Environment and Human Health in the 21st Century

Focus on mitigation of chronic illness through designs aimed to improve:

- Air quality
- Water Quality and Efficiency
- Energy Performance
- Lighting
- Thermal comfort
- Sound Control
- Materials and Resources



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The Built Environment and Human Health Today

Focus on mitigation of chronic illness through designs aimed to improve:

- Air quality
- Water Quality and Efficiency
- Energy Performance
- Lighting
- Thermal comfort
- Sound Control
- Materials and Resources

+ additional concern of infectious disease due to SARS-COV2

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The Built Environment and Human Health Today

Focus on mitigation of chronic illness through designs aimed to improve:

- **Air quality**
- Water Quality and Efficiency
- Energy Performance
- Lighting
- Thermal comfort
- Sound Control
- **Materials and Resources**

additional concern of infectious disease due to SARS-COV2

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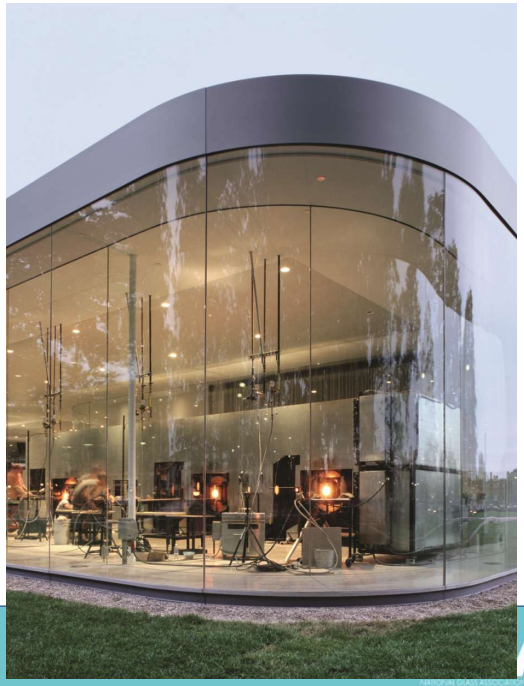
Material Consideration in Design

Humans spend ~90% of their time indoors.

- Material Considerations
- Human Interaction



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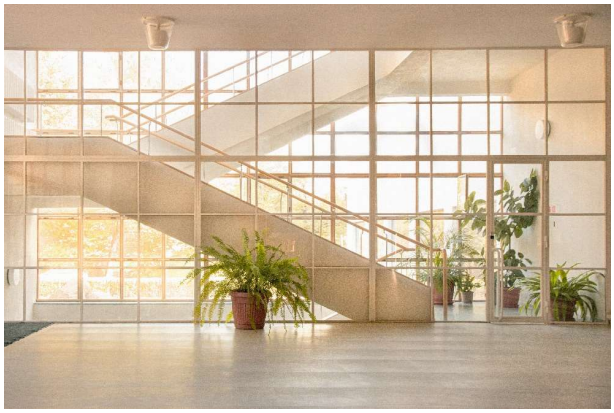
Material Considerations



Indoor Air Quality

- Indoor concentrations of pollutants are often 2-5 times higher than typical outdoor concentrations.
- Indoor concentrations have increased in recent decades due to high-performance building design and increased use of synthetic building materials.

Why does it matter?

- Air pollutants are linked to adverse health effects such as irritation, fatigue, respiratory diseases, heart disease, and cancer.

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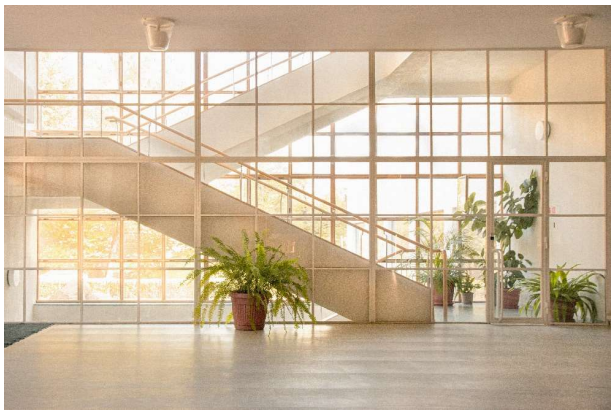
Material Considerations



Volatile Organic Compound (VOC): organic chemical compounds whose composition makes it possible for them to evaporate under normal indoor atmospheric conditions of temperature and pressure

Why do they matter?

- Building materials can contain VOC contaminants that are gradually emitted throughout the life of the material.
- VOCs can be odorous, irritating, toxic or carcinogenic.

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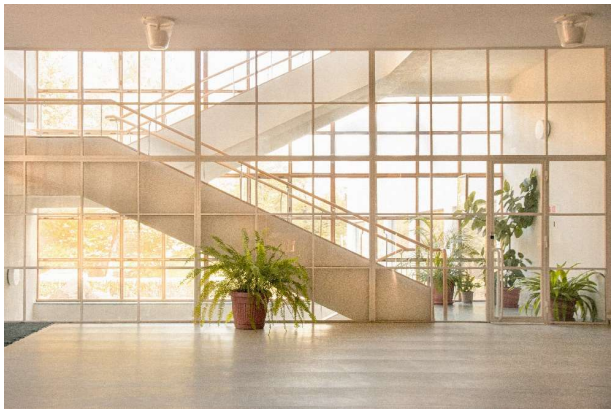
Material Considerations



Conscious material selection and proper building ventilation can help prevent “sick building syndrome”.

USGBC recognizes glass as an inherently non-emitting product.

Coated glass products can have a net positive impact on indoor air quality.

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Human Interaction

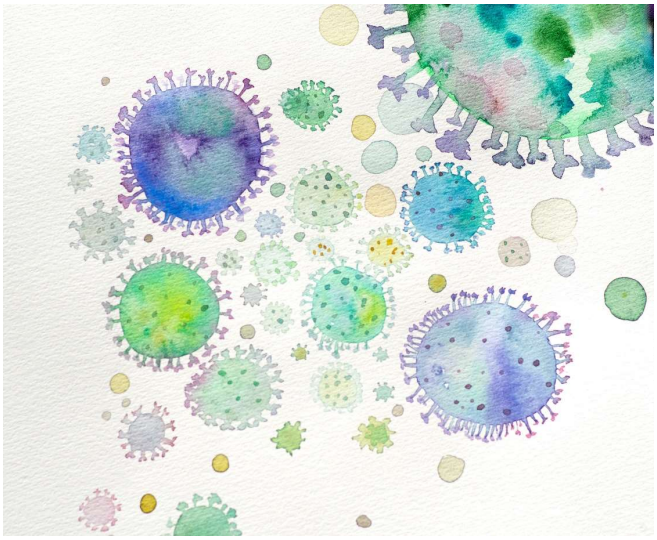
Pathogens: Microbes that cause disease

- Bacteria: E Coli, Staphylococcus, etc.
- Viruses: Influenza A, SARS COV2, etc.

Antibacterial= Effective against bacteria

Antiviral = Effective against viruses

Antimicrobial = Effective against microbes (could be bacteria, viruses, or other)



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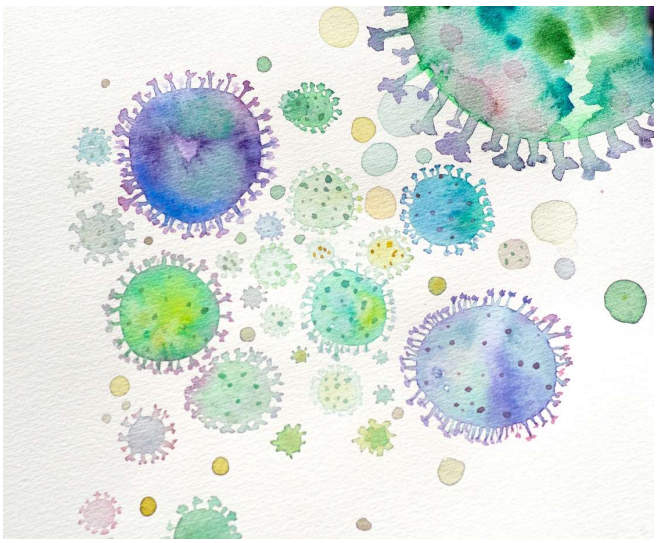
Human Interaction

Infectious Disease Transmission

- Direct Contact
- **Droplet Spread**
- Indirect Transmission
  - Airborne
  - **Vehicle (Fomite)**
  - Vectors



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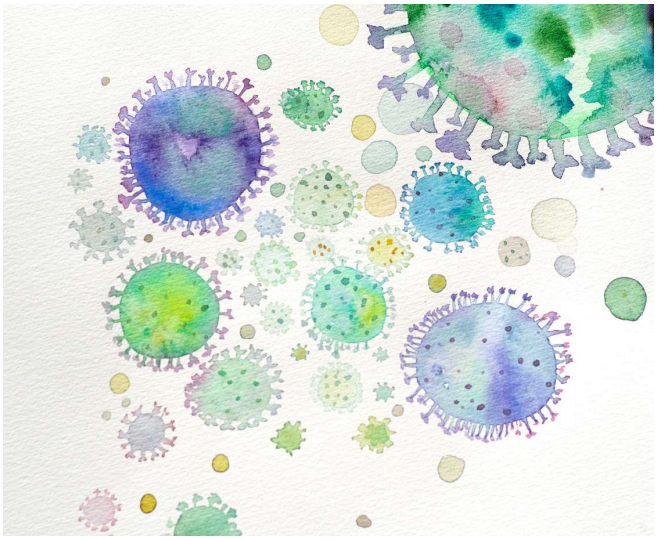
Human Interaction

Methods for microbial abatement

- Wash your hands / use hand sanitizer
- Avoid contact with people who are sick
- Cover coughs and sneezes
- **Clean AND disinfect frequently touched surfaces**



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Section 3: Antimicrobial and Disinfection Glass Technologies

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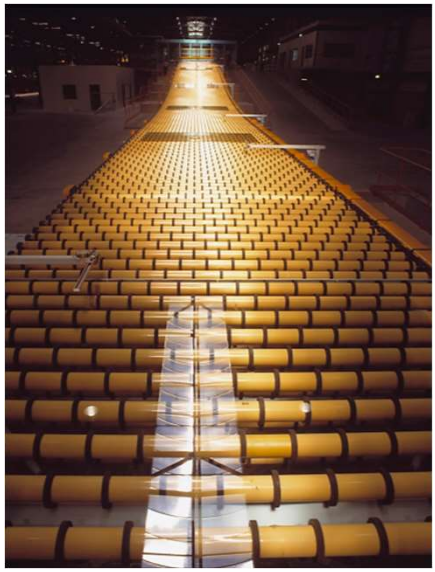
Antimicrobial and Disinfection Technologies

Available Technologies:

- Electrically Conductive
- Silver/Copper
- Photocatalytic (TiO2)



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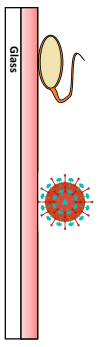
Conductive Coatings for Heated Surface

- Heat has been used as a method to achieve sterilization and disinfection throughout history
- Dry heat sterilization occurs through conduction
  - Heat is absorbed by glass and passed along to bacteria/viruses on the surface of the glass
  - Heat destroys microbes through denaturation of proteins



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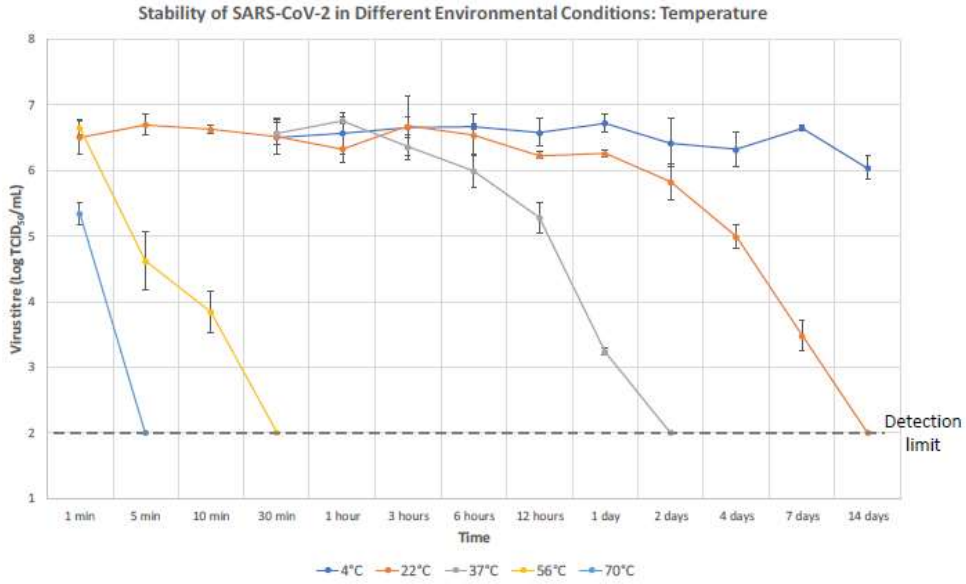
Heated Glazing



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Conductive Coatings for Heated Surface

- SARS-CoV-2 exhibits behavior similar to that of other Coronaviruses such as SARS and MERS, since it is not possible to detect an infecting virus:
  - after 30 minutes at 56°C
  - after 5 minutes at 70°C
- Using conductive coatings, it is possible to heat the glass and take advantage of the high temperatures to neutralize bacteria and viruses.

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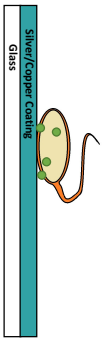
Silver & Copper Coatings

- Antimicrobial Properties
  - Classified as Pesticide by the EPA
- Trace amounts of bactericidal silver / copper ions leach from the surface and kill bacteria through ionization
  - Attach themselves to bacteria, disrupting cell walls and eventually bursting the membranes
- Leach to skin



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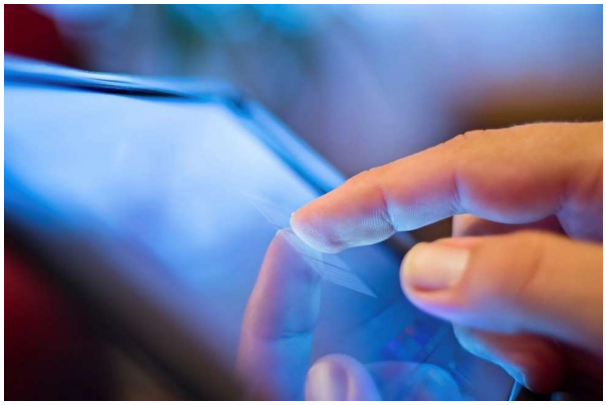
Silver & Copper Coatings

- Eliminates stain and odor causing bacteria
- Used in interior applications
  - Healthcare
  - Touchscreens



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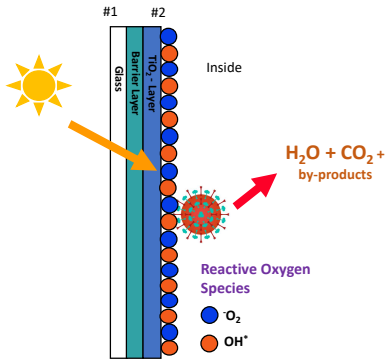
Photocatalytic (TiO2) Coatings

- Antimicrobial Properties
  - Classified as Pesticide Device by the EPA
- Kills bacteria and viruses through photocatalytic reaction
  - UV Energy + Airborne Moisture + TiO2 = Reactive Oxygen Species (ROS)
  - ROS inactivate microbes on surface of the glass through degradation of cell wall and disrupts RNA



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Photocatalytic (TiO2) Coatings

- TiO2 photocatalytic disinfection has been proven to have positive impacts on indoor air quality

TiO2 photocatalysis air quality improvements through reduction of:	Reference
VOC	Simonsen et al. (2011) Shah et al. (2019)
Ozone	Mills et al. (2003)
NOx	Mills et al. (2020) Boyjoo et al (2016)

- Provide net positive impacts to indoor air quality when applied to interior surface of façade glazing

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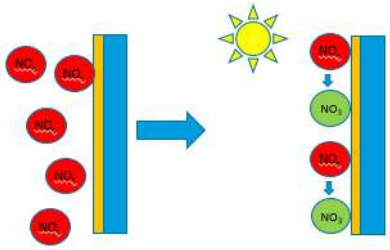
Example: NOx Reduction Performance

- NOx converted to harmless nitrates
- NOx abatement rate= 277.5 µg/(m²*h)
- 0.277 [mg/(m²*h)] x Glass surface [m²]= total NOx abatement [mg] in 1 hour



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Photocatalytic (TiO2) Coatings

- Eliminates stain and odor causing bacteria
- Proven effective against enveloped viruses
- Improves air quality
- Used on interior glazing surface or in combination with UV source
  - Common Areas (lobbies, dining halls, etc.)
  - Healthcare
  - Mass Transit

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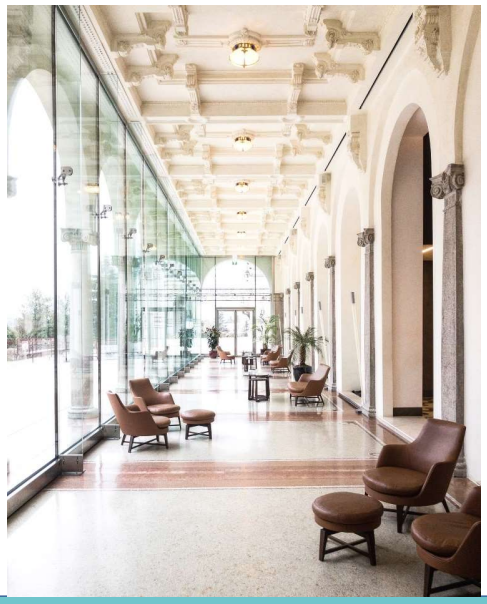
Key Takeaways

- The built environment significantly affects human health.
- Conscious material selection and proper building ventilation can help prevent “sick building syndrome”.
- Glazing materials can contribute to disinfection strategies and reduce risk of surface contamination.



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Thank you for participating in this course

Glass Options for a Healthy Built Environment

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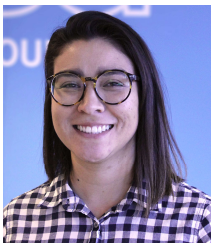
QUESTIONS?

Glass Options for a Healthy Built Environment



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